GERVASIO & ASSOC., INC.
CONSULTING ENGINEERS
77 EAST THOMAS ROAD, SUITE 120
PHOENIX, ARIZONA 85012
(602) 285-1720 • (602) 285-1530 (FAX)

December 4, 2012

Mr. David Frandsen
ARIZONA SCHOOL RISK RETENTION TRUST
333 East Osborn Road, Suite 300
Phoenix, AZ 85012

RE: QUEEN CREEK HIGH SCHOOL - CULINARY ARTS
22149 East Ocotillo Road, Queen Creek, Arizona
ROOF SYSTEM INVESTIGATION
G&A Job No. 1137.1 F

Dear Mr. Frandsen:

In accordance with your request, we have completed our investigation of the roof framing above the Culinary Arts classroom. The following report presents our findings, conclusions and recommendations. We have attached one copy each of thirty-one (31) digital photos from our November 26 and 28, 2012 site inspections by John M. Denny, P.E. of Gervasio & Assoc., Inc.

The original school, including the present Culinary Arts classroom, was constructed in 2002. In 2010, two kitchen hoods which include exhaust fans and large make-up air units were added on the Culinary Arts classroom roof. On a recent roof inspection, a Trust inspector noted the new roof equipment and thought the roof surface in the area of the equipment had unusual deflection characteristics. Chronic roof leaks have also been reported under the units the last 2 years.

The low slope roof system above the Culinary Arts classroom is constructed with 16 inch deep TJI/L90 wood I-joists spaced 2 ft. o.c. The I-joists clearspan 29.25 ft. between wood ledgers attached to masonry bearing walls. The I-joists support a ballasted built-up roof membrane on 1/2 inch wood sheathing and a suspended fire rated ceiling.

During our November 26 roof inspection, we observed some noticeable undulations when performing heel drop tests adjacent to the south unit, but not adjacent to the north unit. The roof deck to the south of the south unit, which supports no concentrated or mechanical loads, also had some noticeable deflection during heel drop tests. There was minor visible sag of the roof system below the larger south unit. We also noticed that there were some isolated low spots on the roof surface adjacent to and underneath the make-up air units where water could pond up to 1 inch deep. The low spots were created during the installation of the additional mechanical equipment in 2010 and are most likely the cause of the chronic roof leaks. During an inspection of the roof framing from below, the I-joists were typically spaced 2 ft. o.c. and no roof reinforcement was observed.

We made a second trip on November 28 to examine available plans at the District Office, as the digital plan files made available to us over the internet were not legible enough for our evaluation purposes. No additional I-joists were added for roof mounted equipment, either on the plans. The 2010 remodel plans also did not include any structural drawings or roof framing reinforcement. We also performed a second inspection of the roof framing below the roof mounted units on November 28 to determine that no I-joists were cut or modified during the equipment installation. No cuts or modifications were observed.

Initial review of the TrusJoist literature indicated that the as-built I-joists had reserve capacity. We performed calculations on the I-joists that included uniform dead and live load and tributary loads from the hood, exhaust fan, make-up air unit and curb. With the additional mechanical loads, the most critical I-joist is stressed to 90 percent of capacity in bending. The I-joists supporting the additional loads require web stiffeners at the bearing points, which were specified at all I-joist bearing locations in the structural notes.

We conclude that the roof framing has adequate capacity to support the additional mechanical loads. The minor sag observed below the south unit is primarily due to the fact that I-joists are manufactured without camber and will experience normal deflection under load. The roof felt a lot stiffer adjacent to the north unit because the I-joists supporting that unit are receiving unintended support from a perpendicular non-bearing partition wall about 9 ft. east of the west bearing.

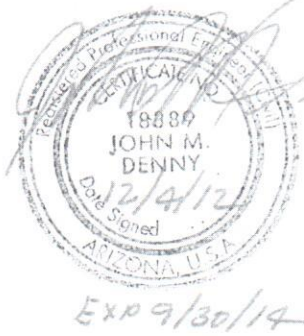
We recommend that the low spots on the roof membrane be eliminated to restore adequate roof slope for quick drainage of rainwater. **We also recommend** that the bearing points of the I-joists supporting the mechanical loads be inspected to confirm that the specified web stiffeners were installed.

This report is based on the facts and evidence known to us as of this date and may be amended if new facts and/or evidence are presented or discovered.

We appreciate the opportunity to provide this service and welcome any questions.

Sincerely,

GERVASIO & ASSOC., INC.



Exp 9/30/14

John M. Denny, P.E.
Asst. Dir., Forensic Department

JMD:blm

Enclosures

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JOB NO.: 1137.1

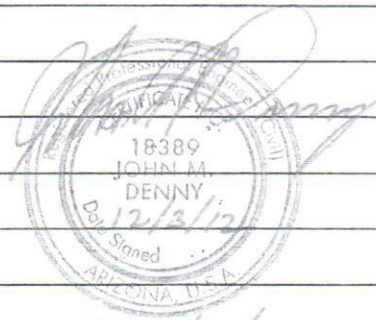
BY: JD

CALCULATIONS

PROJECT: QUEEN CREEK HIGH SCHOOL
22149 E. OCOTILLO
QUEEN CREEK, AZ

CLIENT: AZ SCHOOL RISK RETENTION TRUST

ITEM	SHEET
I JOIST ANALYSIS AT KITCHEN HOOD	C1-2
WOODWORKS ANALYSIS	C3
TJI PRODUCT DESIGN INFO	C4



EXP 9/30/14

GERVASIO & ASSOC. INC.
CONSULTING ENGINEERS

(602) 285-1720 • 77 East Thomas Road, Suite 120
PHOENIX, ARIZONA 85012-3115

Date 12/3/12 Job No. 1137.1

By JMD Sheet No. C1

DESIGN LOADS

LIVE	20 PSF
DEAD	
BUILT UP ROOF W/ BALLAST	8 PSF
1/2" OSB	1.6
16" TJI L90 @ 2' O.C	2.4
BATT INSULATION	0.5
SUSPENDED GRID	0.5
1/2" COATED GYP BD PANELS	2.5
SPRINKLERS	2.0
LIGHTS, MISC	2.5
	20 PSF

KITCHEN HOOD ADDITIONS

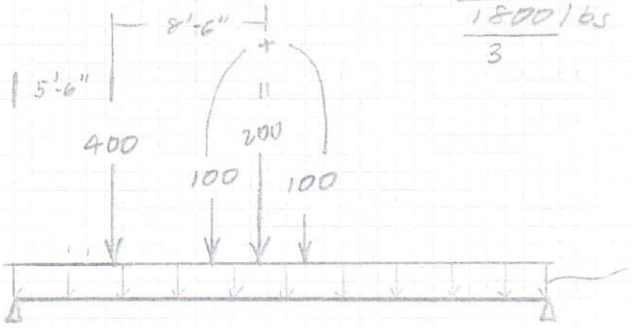
MAU 2-1

EXHAUST FAN	150 lbs
MAKE UP AIR	1200
HOOD	100
CURB, SUPPORTS, ETC	150
	1600 lbs

MAU 2-2

EXHAUST FAN	150
MAKE UP AIR	1400
HOOD	100
CURB, SUPPORTS ETC	150
	1800 lbs

$\frac{1800 \text{ lbs}}{3}$ = 600 lbs / I-JOIST



(20+20)×2 = 80 PLF

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Date 12/3/12 Job No. 1137.1

By JMD Sheet No. C2

FROM WOODWORKS ANALYSIS

SHEAR MAX = 1.6 KIPS = 1600 lbs
MOMENT MAX = 11.15 KIP-FT = 11150 ft-lbs

FROM TRUS JOIST 2001 DESIGN MANUAL

16" TJI/L90 SIMPLE SPAN NON SNOW LOADS (1.25)

VERTICAL SHEAR = 2330 lbs
1 3/4" END REACTION W/O STIFFENER = 1400 lbs
1 3/4" END REACTION W/ STIFFENER = 2030 lbs

RESISTIVE MOMENT = 12425 ft-lbs

1600 lbs ≤ 2030 lbs OK
1600 lbs > 1400 lbs STIFFENERS REQ'D AT BEARINGS
12425 ft-lbs > 11150 ft-lbs OK 90% OF CAPACITY

C3

File Name: BEAM WoodWorks 1.0c

COMPANY	PROJECT

ANALYSIS RESULTS

INPUT LOADS: (force=kips, pressure=psf, udl=plf, location=ft)

Load	Distribute	Type	Magnitude Start	Magnitude End	Location Start	Location End	Pattern Load
1	Full UDL	Dead	40.00				No
2	Full UDL	Live	40.00				No
3	Point	Dead	0.40		5.50		No
4	Point	Dead	0.20		14.00		No

Self-weight of members has NOT been included.

Load combination factors based on: ASCE 7-88
LC# 1 = Dead loads only
LC# n = Dead & Live loads

SHEARS AND BENDING (+ve bending = compression on top):

SPAN	Load Comb.	Shear@ start (kips)	Shear@ end (kips)	Bending@ start (kip-ft)	Bending@ end (kip-ft)	Span_Bending mag. (kip-ft)	Span_Bending loc. (ft)
1	1	1.01	-0.76	0.00	0.00	6.88	14.0
1	2	1.60	-1.34	0.00	0.00	11.15	14.0

VERTICAL REACTIONS (-ve = uplift) [kips] :

Load Comb.	29.2 ft ^	^
1	1.01	0.76
2	1.60	1.34

TJI® Joist Design Properties/Performance Plus® Web Material

Joist Depth	Joist Weight (plf)	Resistive Moment (1) (ft-lbs)	Vertical Shear (2) (lbs)	EI x 10⁶ (in.²lbs)	EI (3) x 10⁶ TJI® Joist with Nailed Plywood Floor Sheathing (in.²lbs)	EI (3) x 10⁶ TJI® Joist with Glue-Nailed Plywood Floor Sheathing (in.²lbs)	End Reaction (lbs) 1¾" Bearing Length Web Stiffeners (8) No	End Reaction (lbs) 1¾" Bearing Length Web Stiffeners (8) Yes	End Reaction (lbs) 3½" Bearing Length Web Stiffeners (8) No	End Reaction (lbs) 3½" Bearing Length Web Stiffeners (8) Yes	Intermediate Reaction (lbs) 3½" 5¼" (7) Bearing Length Web Stiffeners (8) No	Intermediate Reaction (lbs) 3½" 5¼" (7) Bearing Length Web Stiffeners (8) Yes	Intermediate Reaction (lbs) 5¼" 7" (7) Bearing Length Web Stiffeners (8) No	Intermediate Reaction (lbs) 5¼" 7" (7) Bearing Length Web Stiffeners (8) Yes
TJI®/L65 Joist														
11⅞"	3.4	6260	1925	459	511	553	1390	1680	1885	1925	2780	3150	3395	3765
14"	3.7	7655	2125	678	747	801	1390	1680	1885	2125	2780	3400	3395	4015
16"	3.9	8935	2330	930	1014	1081	1390	1680	1885	2330	2780	3525	3395	4140
18"	4.2	9835	2535	1227	1326	1405	1390	1680	1885	2535	2780	3650	3395	4265
20"	4.5	11040	2740	1572	1685	1775	NA	1680	NA	2740	NA	3720	NA	4385
22"	4.8	12245	2935	1967	2093	2193	NA	1680	NA	2935	NA	3720	NA	4510
24"	5.0	12975	3060	2414	2551	2660	NA	1680	NA	3060	NA	3720	NA	4635
26"	5.3	14140	2900	2915	3060	3177	NA	1680	NA	2900	NA	4760	NA	5380
28"	5.6	15305	2900	3473	3624	3745	NA	1680	NA	2900	NA	4885	NA	5505
30"	5.8	16465	2900	4089	4242	4365	NA	1680	NA	2900	NA	5005	NA	5625
TJI®/L90 Joist														
16"	4.7	12425	2330	1246	1343	1420	1400	2030	1885	2330	3355	3985	3970	4605
18"	5.0	13680	2535	1635	1751	1844	1400	2030	1885	2515	3355	3985	3970	4605
20"	5.3	15360	2740	2085	2219	2326	NA	2190	NA	2675	NA	4145	NA	4760
22"	5.6	17040	2935	2597	2748	2869	NA	2345	NA	2830	NA	5090	NA	5710
24"	5.8	18060	3060	3172	3340	3474	NA	2345	NA	2830	NA	5195	NA	6025
26"	6.1	19680	2900	3814	3996	4141	NA	2345	NA	2900	NA	5800	NA	5800
28"	6.4	21300	2900	4525	4718	4872	NA	2345	NA	2900	NA	5800	NA	5800
30"	6.6	22925	2900	5306	5507	5668	NA	2345	NA	2900	NA	5800	NA	5800
TJI®/H90 Joist														
11⅞"	4.6	9730	1925	687	751	801	1400	1715	1885	1925	3495	3810	4100	4420
14"	4.9	11975	2125	1015	1100	1167	1400	1875	1885	2125	3495	3970	4100	4575
16"	5.2	14100	2330	1389	1493	1577	1400	2031	1885	2330	3495	4130	4100	4735
18"	5.4	15685	2535	1827	1952	2053	1400	2031	1885	2515	3495	4130	4100	4735
20"	5.7	17670	2740	2331	2478	2595	NA	2190	NA	2675	NA	4285	NA	4890
22"	6.0	19625	2935	2904	3072	3206	NA	2345	NA	2830	NA	5195	NA	5840
24"	6.3	20810	3060	3549	3735	3885	NA	2345	NA	2830	NA	5195	NA	6155
26"	6.5	22695	2900	4266	4471	4634	NA	2345	NA	2900	NA	5800	NA	5800
28"	6.8	24580	2900	5059	5279	5455	NA	2345	NA	2900	NA	5800	NA	5800
30"	7.1	26465	2900	5930	6163	6349	NA	2345	NA	2900	NA	5800	NA	5800

The stated allowable design properties are for loads of normal duration. Adjustments to the allowable design values shall be in accordance with the applicable code.

(1) Resistive Moment values may be increased 4% for repetitive member usage. See page 9.7 for criteria.
(2) For possible increases in shear capacity see below.
(3) For deflection calculation only. Assumes ¾" plywood or other wood-based structural use panels.
(4) Interpolation between bearing lengths and joist depths is permitted for allowable design reactions.
(5) The minimum bearing length is permitted to be reduced for joists supported by hangers if supplemental nail attachment is provided to the web stiffener.
(6) Allowable bearing lengths have been determined based on Trus Joist products. Allowable bearing on supporting members shall be checked.
(7) Shaded areas indicate 5¼" and 7" bearing lengths at intermediate reactions.
(8) Refer to page 9.3 for web stiffener details.

TJI® Joist Shear Design

When joists are used as simple-span members, the design shear is equal to the shear at the face of the support.

When joists **up to 24" in depth** are used as multiple-span members, the design shear is the calculated shear at the interior support reduced by the following:

$$R = \frac{W}{19.25} \leq 18\%$$

Where: R is the percent reduction
W is uniform load in plf